

Nutritional, sensory and textural qualities of *bhajjiya* supplemented with pumpkin (*Cucurbita maxima*) powder

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Abstract

Attempts were made to prepare pumpkin (*Cucurbita maxima*, Var. MPH-1) powder using vacuum drying and evaluated for supplementation in *bhajjiya*, an Indian savory. The potential of the powder as composite with gram flour in *bhajjiya* production were evaluated with respect to nutritional, sensory and textural qualities. *Bhajjiya* were prepared by replacing gram flour with pumpkin powder at different levels viz. 0, 2.5, 5.0 7.5 and 10% (w/w) in the commercial formulation. The influence of replacement of gram flour in *bhajjiya* with pumpkin powder resulted in a significant change in the textural and sensory qualities of *bhajjiya*. As the replacement level of gram flour with pumpkin powder increased from 0 to 10% (w/w), the hardness and chewiness was decreased and springiness and resiliency was increased. *Bhajjiya* prepared by replacing gram flour with pumpkin powder at the level of 7.5% (w/w) was found to be more acceptable from sensory point of view. Level of carbohydrate, crude fibre, ash, calcium and potassium was found considerable increased in *bhajjiya* prepared by replacing gram flour with pumpkin powder at the rate of 7.5% (w/w). *Bhajjiya* with more pumpkin powder had a more yellow color than those with less pumpkin powder. Addition of more pumpkin powder increased the level of carotene in the *bhajjiya* significantly.

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Introduction

Gram flour which is popularly known as ‘besan’ is an important ingredient used for making various traditional style recipes. It is used in sweet as well as spicy food and snacks preparations. It is a versatile product used in many preparations round the year. Apart from individual households, there are some institutional bulk consumers like restaurants, other eateries, canteens, clubs and caterers, etc. Gram flour is very commonly used item in the Indian kitchens and thus enjoys continuous market throughout the year. Among all the fried snack products, *bhajjiya* an Indian savory which is prepared from gram flour and mixed spices is more popular among the all age group population. *Bhajjiya* are generally prepared from the gram flour. Qualities of the *bhajjiya* such as color, taste and texture are more important affecting the consumer acceptance. In recent years these *bhajjiyas* are fortified with various nutrients to enrich them to become a complete food with all necessary nutrients. The base material used for the preparation of *bhajjiya* i.e. gram flour contains a limited amount of β-carotene which is considered as precursor of vit A which is available in variety of fruits and vegetables (Olson, 1989; Tee and Lim, 1991). In this research paper an attempt has been made to enhance the level

of β-carotene in *bhajjiya* by using pumpkin powder as a source of β-carotene. Pumpkins are extensively grown in tropical and subtropical countries where it is traditionally consumed in the form of freshly boiled, steamed or as a processed food items such as soup or curry. Pumpkin is high in β-carotene, which imparts yellow to orange color (Bhaskarachary *et al.*, 2008). Among carotenoids, β-carotene is most widely used in food industry. This is because it has no fixed usage rate and can be added in any amount to obtain desired colour. It provides uniform natural colour, enhances colour, imparts yellow colour and adds to vit A activity (Gayathri and Prakash, 2003; Lee, 1983). Extent of deficiency of vit A in the diets of male and female is 80 and 84%, respectively and is the highest among the deficiency of other micronutrient i.e. iron (62%), riboflavin (50%), vit C (30%) (NNMB, 2002). Consumption of foods containing carotene helps in prevention of eye disorders, cancer and skin diseases (Bendich, 1989). Incorporation of β-carotene rich foods in diets is the best measure to improve vit A nutrition of individuals to overcome the problems and diseases caused by vit A deficiency (Chandrashekhar and Kowsalya, 2002; Siems *et al.*, 2005). The pumpkin powder was prepared from the flesh of pumpkin by vacuum drying technique in this study. The objective of this study was to determine

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the appropriate substitution level of pumpkin powder for the gram flour in the formulation of *bhajjiya* and to assess the effect of pumpkin powder added to *bhajjiya* on sensory and textural characteristics of *bhajjiya*.

Material and Methods

Materials

The matured pumpkin (*Cucurbita maxima* Var. MPH-1) fruits were procured from the research farm of Anand Agricultural University, Anand and ingredients for *bhajjiya* were purchased from the local market. Authentic β -carotene (Himedia) was used as the standard. All chemicals used in the experiment were of analytical grade.

Pumpkin powder production

The peeled pumpkin fruit was converted into 10 mm size cubes and subjected for pretreatments such as blanching (temperature 94°C, time 2 min.) and sulphitation carried out in 500 ppm solution of $K_2S_2O_3$ prior to drying. The pretreated cubes of pumpkin fruit were dried for preparation of powder using vacuum dryer. Vacuum drying of pumpkin cubes was carried out at 80°C and 700 mm Hg vacuum. The Pumpkin powder was analyzed for carotene content.

Preparation of *bhajjiya*

The *bhajjiya* was prepared in a traditional way. Firstly, the dry spices (Cinnamon, Clove, Coriander seed and Black pepper) were ground into powder. These powdered spices were mixed together as per the commercial recipe (Table 1). Leavening agent, salt and gram flour were added to the mixture of spices. All the dry ingredients were mixed thoroughly. Slowly the water was added to the dry mix and mixed thoroughly to obtain the homogeneous batter of desired consistency. The batter was held for 5–8 min for leavening. Simultaneously, good quality edible oil (Brand: Sundrop, Sunflower seed oil) was heated and maintained at 140°C in frying pan using sensors. The frying was carried out by dropping the batter in the form of small uniform balls in hot oil for 4 min. After frying, the excess oil was drained off from the fried balls and served hot. In this way the control *bhajjiya* sample was prepared with average diameter of 3.8 cm. For the test samples, the gram flour in the formulation was replaced with pumpkin powder @ 2.5, 5.0, 7.5 and 10.0 percent (w/w) and processed as above. Each sample was prepared in duplicate.

Chemical analysis

The chemical properties of the pumpkin powder substituted samples were determined and compared

Table 1. Recipe for *bhajjiya*

Ingredient	Percent (f.b.)
Gram flour(besan)	100
Leavening agent	1.0
Salt	1.5
Cinnamon	0.16
Clove	0.16
Coriander seed	2.66
Black pepper	0.23
Water	80
Replacement level of gram flour with pumpkin powder	0, 2.5, 5.0, 7.5 & 10 % (w/w)

Table 2. Machine settings for texture analysis of *bhajjiya*

Specifications	Values
Probe	75 mm compression platen
Mode	Compression
Load cell (kg)	100
Pre-test speed (mm/s)	1
Test speed (mm/s)	5
Post test speed (mm/s)	20
Hold time (s)	5
Trigger type	Auto
Tare mode	Auto
Data acquisition rate (pps)	200
Distance travelled during compression	2.85 cm

with control sample. Moisture, protein, fat, carbohydrate, ash, crude fibre, ascorbic acid, total carotene, calcium, phosphorus, iron and potassium were analyzed using the standard methods (AOAC, 1990).

Texture analysis

Freshly prepared samples of *bhajjiya* (within 5 minutes of frying) were studied for the effect of various replacement levels of gram flour with pumpkin powder on its hardness, springiness, chewiness and resilience, using Texture Analyzer (Stable Microsystems, UK, Model TAHDi) with the test settings reported in Table 2.

Sensory evaluation

Sensory parameters such as appearance, taste, flavor, color, texture and overall acceptability were evaluated by trained panel consisting of 6 persons using 9-point hedonic scale (from like extremely = 9 to dislike extremely = 1) (Watts *et al.*, 1989).

Statistical analysis

Statistical analysis was carried out using Complete Randomized Design (CRD) giving analysis of variance (AVOVA) for significance at 5% of each treatment (Panse and Sukhatme, 1985).

Results and Discussion

Effect of replacement of gram flour with pumpkin powder on textural quality of *bhajjiya*

Replacement of gram flour with pumpkin powder in the preparation of *bhajjiya* resulted in a significant change in its textural quality. Figures 1 and 2 illustrate the effect of replacement of gram flour with pumpkin powder on the hardness, chewiness, springiness and resilience of *bhajjiya*. As the replacement level of pumpkin powder was increased from 0 to 10%, the

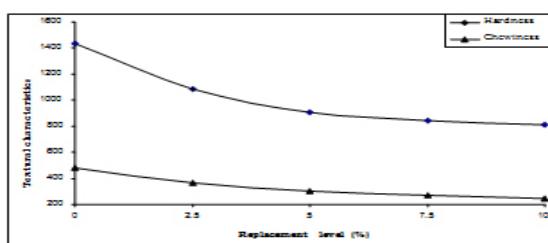


Figure 1. Effect of replacement level of gram flour with pumpkin powder on hardness and chewiness of *bhajjiya*

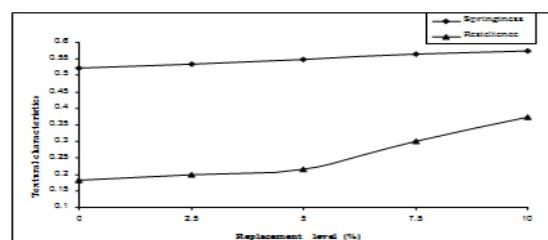


Figure 2. Effect of replacement level of gram flour with pumpkin powder on springiness and resilience of *bhajjiya*

amount of force required to compress the *bhajjiya* decreased considerably. On replacing 2.5% of gram flour with pumpkin powder, the hardness of the *bhajjiya* decreased to 1084 g from that of 1434 g for the control sample having no pumpkin powder. Further increase in the replacement level to 5.0, 7.5 and 10% of gram flour by pumpkin powder, resulted in decrease of the hardness of *bhajjiya* to further lower levels of 904, 844 and 810 g, respectively. Correspondingly, the chewiness of *bhajjiya* also decreased with increasing the replacement level of gram flour by pumpkin powder from 0 – 10% (w/w). For example, the chewiness of *bhajjiya* of control sample was 478 g. But, further increase in replacement level to 2.5, 5.0, 7.5 and 10%, decreased the chewiness of *bhajjiya* to 365, 304, 271 and 247 g, respectively.

It was also observed that with the increase in the replacement level from 0 - 10% of gram flour by pumpkin powder in *bhajjiya*, the springiness and resilience increased considerably. On replacing 2.5% of gram flour with pumpkin powder, the springiness of the *bhajjiya* increased to 0.535 g from that of 0.522 g for the control sample. Further increase in replacement level to 5.0, 7.5 and 10%, increased the springiness of *bhajjiya* to 0.547, 0.565 and 0.574 g, respectively. Similarly, increasing the replacement level of gram flour with pumpkin powder, resilience in the product also increased. The resilience of control sample of *bhajjiya* with no addition of pumpkin powder was only 0.181 but as the replacement level of gram flour with pumpkin powder was increased to 2.5, 5.0, 7.5 and 10%, the resilience of *bhajjiya* increased to 0.198, 0.215, 0.301 and 0.373, respectively.

Table 3. Mean sensory score for *bhajjiya* prepared by replacing gram flour with pumpkin powder

Replacement level (%)	Sensory score					
	Appearance	Taste	Flavour	Colour	Texture	Overall acceptability
0 (Control)	5.05	4.96	5.10	4.83	4.48	4.71
2.5	5.56	5.56	5.51	5.98	5.48	5.53
5.0	6.65	6.51	6.70	6.86	6.65	6.64
7.5	7.44	7.95	7.81	7.88	7.61	8.03
10.0	7.35	7.40	7.53	7.73	7.96	7.55
CV (%)	17.95	12.92	10.97	11.98	10.91	9.71

Table 4. Chemical composition of *bhajjiya* with optimized level of replacement of gram flour with pumpkin powder

Sr. No.	Constituent	Control sample	Optimized sample
1	Moisture (%)	33.48±0.05	34.01±0.04
2	Carbohydrate (%)	27.99±0.19	29.9±0.11
3	Protein (%)	18.64±0.26	16.765±0.10
4	Fat (%)	13.56±0.34	15.095±0.03
5	Crude fibre (%)	0.171±0.01	0.4395±0.02
6	Ash (%)	4.42±0.01	5.1885±0.03
7	Carotene (µg/100 g) %	80.7±1.13	2059±5.65
8	Calcium (%)	0.185±0.01	0.2125±0.02
9	Phosphorous (%)	0.245±0.01	0.2965±0.01
10	Potassium (%)	0.335±0.02	0.425±0.03
11	Iron (ppm)	49.5±4.94	60.5±3.53

Values are mean ± standard deviation of three determinations.

These phenomena of gradual decrease in hardness and chewiness and increase in springiness and resilience with the increase in replacement level of gram flour with pumpkin powder is due to the higher oil absorption capacity of pumpkin powder as compared to that of the gram flour and moreover, carotene content of pumpkin powder is more oil soluble. Hence, with the increase in replacement level of gram flour with pumpkin powder in *bhajjiya*, the oil uptake during frying has increased and due to that the softness has increased with increased springiness and resilience.

Effect of replacement level of gram flour with pumpkin powder on sensory quality of bhajjiya

The mean scores of different sensory parameters of *bhajjiya* prepared by replacing gram flour with pumpkin powder at different levels are presented in Table 3.

Appearance

The mean score for appearance of the *bhajjiya* gradually increased from 5.05 to 7.44 with increasing the replacement of gram flour with pumpkin powder. It was observed that the *bhajjiya* sample prepared by replacing gram flour at 10% (w/w) with pumpkin powder scored the maximum (7.44). As the level of replacement was increased from 2.5 to 7.5%, the appearance of the *bhajjiya* became superior.

Taste

The mean score for taste of the *bhajjiya* also increased gradually from 4.96 to 7.95 with the increase in replacement level of gram flour with pumpkin powder. It was observed that *bhajjiya*

prepared by replacing 7.5% (w/w) gram flour with pumpkin powder scored the maximum (7.95). It is evident from the score that as the replacement level increased from 2.5%, the likeness was increased from taste point of view.

Flavour

The mean score for flavour ranged between 5.10 and 7.81 with different levels of replacement of gram flour with pumpkin powder. Flavour likeness in sample with replacement level beyond 2.5% increased as there was increase in characteristic flavour. It was observed that the *bhajjiya* sample prepared by replacing 7.5% gram flour with pumpkin powder scored the maximum of 7.81. It is evident from the data that replacement level of 7.5% was very much accepted from flavor point of view in *bhajjiya*.

Colour

The mean score for colour varied from 4.83 to 7.88. The maximum value corresponded to *bhajjiya* sample prepared by replacing gram flour with pumpkin powder at the level of 7.5% and the minimum value corresponded to the control sample. Increase in replacement level of gram flour with pumpkin powder upto 7.5% increased the likeness of *bhajjiya* from colour point of view as the colour became gradually appealing i.e. yellowish with increase in replacement level.

Texture

The mean score for texture varied from 4.48 to 7.96. Replacement level increased the liking of the product gradually from texture point of view. As the level of replacement was increased from 2.5 to 10.0%, the texture of the *bhajjiya* became superior due to the gradual increase in softness and springiness, which is desired in *bhajjiya*. The maximum value corresponded to the sample of *bhajjiya* prepared by replacing gram flour with pumpkin powder at the level of 10.0%. The minimum score was of the control sample. It is also evident from the data mentioned in Figure 1 and 2, that the hardness and the chewiness of *bhajjiya* decreased and the springiness and resilience increased with the increase in replacement level.

Overall acceptability

The mean score for overall acceptability varied from 4.71 to 8.03. The liking for *bhajjiya* samples prepared with replacement level was gradually increased with increase in replacement level as they were found superior in appearance, taste, flavour, colour and texture. The maximum value corresponded to the sample prepared with a replacement level of 7.5% of gram flour with pumpkin powder which was

having score of 8.03, while the control sample with no addition of pumpkin powder was with minimum score of 4.71. It was observed that the maximum replacement level of 7.5% (w/w) of gram flour with pumpkin powder was more accepted and scored high. It was observed that replacement of gram flour with pumpkin powder in *bhajjiya* formulation had an appealing effect on sensory properties of the *bhajjiya*. Good quality of *bhajjiya* from sensory point of view can be prepared by replacing 7.5% (w/w) of gram flour by pumpkin powder.

ANOVA was carried out for the whole sensory data and is presented in Table 3. The results showed that increasing replacement level from 0 to 10% (w/w) of gram flour with pumpkin powder had a significant influence (at 5% level of significance) on appearance, taste, flavour, colour, texture and overall acceptability of the *bhajjiya* samples.

Chemical composition of bhajjiya

The replacement level of gram flour with pumpkin powder in the *bhajjiya* was optimized as described above. A *bhajjiya* sample with the optimized level (7.5%) of replacement of gram flour with the pumpkin powder was prepared. The chemical composition of the above sample as well as the control sample was determined (Table 4).

The results indicate that the carbohydrate in optimized sample of *bhajjiya* was higher over the control sample ($27.99 \pm 0.19\%$ to $29.9 \pm 0.11\%$). Little increase in moisture content of the *bhajjiya* was observed after replacing gram flour with pumpkin powder over the control sample from 33.48 ± 0.05 to $34.01 \pm 0.04\%$.

On the other hand, the protein content of optimized sample was decreased over the control sample (18.64 ± 0.26 to $16.765 \pm 0.10\%$). This might be due to the fact that the protein rich gram flour was replaced by the carbohydrate rich pumpkin powder in the preparation of product. Due to the replacement of gram flour with pumpkin powder, the crude fiber content of optimized sample increased over the control from 0.171 ± 0.005 to $0.4395 \pm 0.021\%$. Fat content increased considerably from 13.56 ± 0.34 to $15.095 \pm 0.03\%$. Ash content in optimized sample was higher over the control sample ($4.42 \pm 0.01\%$ to $5.1885 \pm 0.03\%$) and hence, the minerals such as calcium, phosphorous, potassium and iron were more in the optimized *bhajjiya* sample as compared to the control sample. Carotene content was very less in control sample i.e. $80.7 \pm 1.13 \mu\text{g}/100 \text{ g}$ but due to 10.0% (w/w) replacement of gram flour with pumpkin powder in the final *bhajjiya*, the carotene content was increased to $2059 \pm 5.65 \mu\text{g}/100 \text{ g}$. This is very important considering the increase in the vit A

value of the product.

Conclusions

This study revealed the effect of replacement of gram flour with pumpkin powder on the textural and sensory qualities of *bhajjiya*. The pumpkin powder could be very well utilized to prepare the *bhajjiya*. As the replacement level of gram flour with pumpkin powder was increased from 0 to 10% (w/w), the hardness and chewiness was decreased and springiness and resiliency was increased. On the basis of textural and sensory characteristics, the replacement level at 10% (w/w) of gram flour with pumpkin powder was found to be optimum for the preparation of carotene enriched *bhajjiya*. The *bhajjiya* prepared with optimum level of replacement i.e. 10% (w/w) of gram flour with pumpkin powder was found to be high in carbohydrate, crude fibre, carotene and mineral matter.

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